2003-06

Assessing internet competence

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THESIS

ASSESSING INTERNET COMPETENCE

by

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March, 1995

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE March 1995	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE ASSESSING INTERNET COMPETENCE	5. FUNDING NUMBERS
6. AUTHOR(S) Musgrove, Albert F.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum of 200 words)*
This study examines the current state of Internet usage among Information Technology Management (ITM) students at the Naval Postgraduate School (NPS). ITM students are the Department of Defense (DoD) Information Technology (IT) experts of tomorrow. Their ability to use the Internet is an integral part of their future job performance. This study uses direct observation to determine ITM students' ability level in performing basic Internet tasks. The results of these observations are used to show trends and changes in ability between ITM sections. These trends are used to draw conclusions as to the methods and sources current used to instruct ITM students in Internet usage. This study showed a need for more formalized Internet instruction at NPS. Recommendations are made for both tutorials and classroom instruction. Future research into the effectiveness of new instructional methods is also recommended. These results and recommendations are applicable for export to all DoD Internet users.

14. SUBJECT TERMS Internet, Resouce Discovery, Instruction, Information Location, Information Acquistion	15. NUMBER OF PAGES 70
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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ASSESSING INTERNET COMPETENCE

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

ITM students are the Department of Defense (DoD) Information Technology (IT) experts of tomorrow. Their ability to use the Internet is an integral part of their future job performance. This study examines the current state of Internet usage among Information Technology Management (ITM) students at the Naval Postgraduate School (NPS). This study uses direct observation to determine ITM students' ability level in performing basic Internet tasks. The results of these observations are used to show trends and changes in ability between ITM sections. These trends are used to draw conclusions as to the methods and sources currently used to instruct ITM students in Internet usage. This study shows a need for more formalized Internet instruction at NPS. Recommendations are made for both tutorials and classroom instruction. Future research into the effectiveness of new instructional methods is also recommended. These results and recommendations are applicable for export to all DoD Internet users.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to examine the current state of Internet usage by Information Technology Management (ITM) students at the Naval Postgraduate School (NPS) in Monterey, California. The current state of usage, for the purposes of this thesis, consists of the student's ability to use the Internet along with the current instructional sources which teach the students this ability.

ITM students will become DoD's information technology managers of the future. It is assumed that there is some advantage to having DoD IT managers who are well-versed in using the Internet. This thesis will examine these theoretical advantages of Internet usage, and help ensure that ITM students are being prepared to use the Internet in the future.

This thesis will not solely benefit ITM students, however. All graduates from NPS should be literate in the use of the Internet. The results of this study will be applicable to all graduates of NPS as well as other Internet users through out DoD.

B. RESEARCH QUESTIONS

There are two primary research questions in this thesis. One looks at the ability of ITM students, while the other looks at the current source of Internet instruction.

Is there a relationship between experience and the ability to use the Internet effectively? It would seem obvious that the ability of a student to perform a given task would be proportionate to the experience or knowledge level of that student. This research question will confirm this fact. It will also, however, provide a measure of

ability at various points on an experience timeline. This should be useful in determining methods to improve the learning process, if necessary.

What instructional source has taught ITM students to use the Internet? In other words, where are the students learning how to use the Internet? The students may be learning from three different categories of sources. They may be learning from informal sources such as their fellow students or by exploring on their own. They could be learning from formal instruction such as class assignments, or they could be learning from semi-formal sources such as computer center classes or personnel. This is of interest, especially if the prior research question shows that changes are necessary.

C. SCOPE

This thesis will consist of an observation of a sample set from the ITM student population to answer the primary research questions. Five students from each of the four present ITM sections, PM33, PM41, PM43, and PM51, will be used as the sample set. Students will be observed performing a series of tasks using their Unix accounts in one of the NPS computer center labs. Their ability to perform the task will be noted. The time required will also be recorded. The methodology of this observation process is discussed in much greater detail in Chapter II.

The information gathered in these observations will then provide the basis for the conclusions and recommendations made in this thesis.

D. LITERATURE REVIEW

1. Learning Theory

A short overview of learning theory and its application to computer based tasks is important to the overall understanding of why the students' performance did or did not

meet the expectations of the researcher. It is also important to the development of ways to improve upon current instructional conditions.

There are two parts to describing the learning process. First, there is the type of knowledge with which we are dealing, and second, there is the process of knowledge instruction

2. Knowledge Types

There are three basic categories of knowledge: declarative, procedural, and self-knowledge. (Dillon & Sternberg, 1986)

Declarative knowledge is the raw facts associated with a subject. It is usually a hierarchial elaboration on a given subject, with the most detailed information contained at the very bottom of the structure. There is no need to use the knowledge, only to be able to present it. An example of declarative knowledge would be the rote recital of dates on a history examination.

Procedural knowledge is knowledge which gives the ability to perform some function. It is the natural follow-on to declarative knowledge. Procedural knowledge requires more sophisticated reasoning on the part of the user, as the user must develop different sets of logic for different tasks.

Self-knowledge is an awareness of one's reasoning process. It involves accessing the logic used in procedural tasks and examining it for strengths and weaknesses. This is the most advanced form of knowledge.

Procedural knowledge was most relevant for this study. It allowed the students to perform the given tasks on the Internet.

3. Knowledge Instruction

There are four phases to knowledge instruction (Alessi & Trollop, 1991):

1. Presenting information.
2. Initial acquisition.
3. Fluency and retention.
4. Assessment.

Presenting information and initial acquisition normally take place at the same time. In a classroom, for example, an instructor presents the information at the same time as a student begins to retain it. This can be accomplished either by classroom instruction or by tutorials. This corresponds to the learning of declarative knowledge.

Fluency and retention require the use of drills which cause a student to work through a problem on his or her own. Success provides the procedural knowledge that students must use to complete the tasks in this thesis.

The last area of knowledge instruction is the assessment or testing of ability. This provides validation to both the instruction method and the student's ability.

In general, computer based learning is an automated application of the techniques already in use manually, especially tutorials. The current advantage of computer usage is increased speed and attention-holding capability. (Ngwenyama, 1993)

The phases of instruction of most interest to this study are fluency and retention, and assessment. Assessment will help determine the current state of the ITM student population and fluency and retention will help develop ways to improve it.

4. Current Benefits of Internet Usage

The benefits of Internet usage are central to why this study was conducted. Therefore, we must look at what the Internet is and why its use by ITM students is important.

The Internet is the largest computer network in the world, primarily supported by government grants. The origin of the Internet was the DoD's Advanced Research Projects Agency Network (Arpanet) begun in the late 1960's. In 1983, the Transmission Control

Protocol/Internet Protocol (TCP/IP) was made mandatory by the Defense Communications Agency for both the Arpanet and the Milnet, a DoD network. After this point, commercial enterprises began to produce products to this standard. The collection of over 17,000 networks that now share this protocol is known as the Internet. The largest backbone of the Internet is now the National Science Foundation's NSFnet with over 4,000 networks linked to it. In 1992, the Internet had over 1 million host computers with many millions of users.(Perry, 1992)

The benefit of using the Internet to find and retrieve information is a more productive group of students. Students with an ability to access information on the Internet are not tied to geographic locations, such as an institution library. Nor are they excluded from access to information due to academic position or standing. (Watson, 1994)

However, using the Internet is not intuitive. Since the Internet is decentralized, there are no common standards and no formal advertisement of information locations. The Internet is far too large for the imposition of a hierarchical structure. (Schwartz, 1993)

As an example to illustrate the need to provide efficient locating capabilities for Internet information, in December 1991, the University of Colorado conducted a study involving the monitoring of File Transfer Protocol (FTP) traffic. During the course of the study (13 days), 39,324 files were transferred. However, this was only 44 percent of the actual FTP traffic. The remaining traffic was directory requests, or in other words, individuals looking around for information. (Schwartz, 1993)

What is needed is a set of services which allow the user to search and retrieve the various information available on the Internet. This will allow students to achieve the full potential of Internet usage. (Obraczka et al, 1993)

E. BASIC INTERNET TOOLS

As previously discussed, the decentralized nature of the Internet means that information may be found at many different sites, and, possibly, in several different formats. The location of information may or may not be published, or known to the user. Users are often required to use a variety of tools to search for and acquire desired information, such as text files, current research material, and colleagues e-mail addresses. An understanding of theses tools is needed prior to conducting the observation of ITM students attempting to perform various Internet tasks. (Schwartz, 1993)

Table 1 shows a basic set of tools that may be used in the Internet. It is not intended to be an exhaustive list, but instead as an overview of current capabilities.

Electronic Mail. Simple Mail Transfer Protocol (SMTP) allows the user to send mail across the Internet regardless of the user's own particular file system. The Internet provides a series of relay mail servers which use the mail's Internet Protocol(IP) address as a means to determining the mail's ultimate destination. Mail is normally short messages in ASCII text. ASCII text is generic text that has been stripped of program specific control characters. (Postel, 1982)

Netfind. The use of electronic mail relies on knowledge of a recipient's e-mail address. Netfind locates unknown e-mail addresses. It uses the search mechanisms available within each individual domain's network mail server rather than a common format that would be needed for a central database.

To begin a Netfind search, a user provides a desired person's name and a short group of keywords describing the possible location of the desired person. An example of such a string could be "smith navy mil." Netfind then uses this information in a seed database which contains a listing of possible domain matches. It then asks a user to pick the domains he or she desires to search. In the example, Netfind may return "nps.navy.mil", "usna.navy.mil", and nosc.navy.mil." Once the user chooses a desired domain, Netfind queries the SMTP server as to all possible mail forwarding information

Internet Tool	Use
Electronic Mail (E-Mail)	Electronic communication
Netfind	Locate E-Mail addresses
FTP (File Transfer Protocol)	Transfer of files
Gopher	A public access distributed document retrieval system
Veronica	Keyword searching of document titles at Gopher sites
WAIS (Wide Area Information Servers)	Full-text searching of distributed documents
Telnet	Access to remote machines
WWW (World Wide Web)	A public access distributed hypertext and multimedia document retrieval system
Web Robots	Keyword searching of pages at WWW sites

Table 1. Basic Internet Tools and their Uses
After Watson, 1994

on each machine at that domain. Netfind uses the "finger" command to return all possible e-mail addresses for the desired individual on each machine.

The seed database constantly updates itself from a variety of e-mail monitoring and reporting services. Since 1993, Netfind could search over 9,000 sub-domains, containing the e-mail addresses of approximately 5.5 million users. This includes 191 sub-domains in the ".mil" domain. (Schwartz, 1993)

FTP. File Transfer Protocol allows a user to transfer files between two computers. The most common use on the Internet is anonymous FTP. In anonymous FTP, the user has access to a computer system without having an account. This allows any user to obtain a large amount of information, without the usual account overhead. (Rovers, 1994)

Gopher. Gopher is a hierarchical structure that allows users to retrieve distributed information on the Internet. Gopher organizes information into a series of directories and sub-directories, with the lowest level being the actual files. Users navigate through gophers using a hierarchical tree structure. (Obraczka et al, 1993)

Veronica. Veronica does keyword searches on a database of titles of gopher items, both files and directories. The Veronica service performs its function in two parts. First, menu data for constructing the database is gathered from registered gopher servers. The listing of registered gopher servers is maintained at the University of Minnesota. Second, Veronica allows users to conduct keyword searches on this database. These two functions are not necessarily performed by the same machine; the database may be obtained from a common repository. (Foster & Barrie, 1993)

WAIS. Wide Area Information Servers is a full-text information retrieval architecture. It works by having a central "Directory of Services" which points a user to the database that contains the information they desire.

To conduct a WAIS search, a user prepares a query which is transmitted in the WAIS protocol to the "Directory of Services," or yellow pages, which is installed on a known WAIS server. The "Directory of Services" forwards the query to all relevant databases, based on its knowledge of what these databases contain. A specific database

then returns the user a ranked listing of all objects which contain the desired text string.

Each individual database is responsible for providing updated content information to the central yellow pages. Currently there are over 300 databases referenced by the "Directory of Services." (Obraczka et al, 1993)

World Wide Web. The World Wide Web was developed at CERN (European Laboratory for Particle Physics) in Switzerland. It uses a distributed structure supported by a graphical user interface(GUI) using hypertext techniques. Data is organized into text objects which are linked to a series of hypertext cover sheets or index objects known as Web-pages. (Obraczka et al, 1993)

Web Robots. A Web Robot explores the Internet autonomously to find new information. It does this by starting with a known WWW document and identifying new places to explore by looking at the links from that document to other documents. It then repeats the process indefinitely, while compiling indices of the information it encounterers. When a Web Robot is sent a query by a user, it uses these indices to provide a listing of relevant WWW sites. (Pinkerton, 1995)

For convenience, these tools can be divided into three categories:

1. Those which allow the Internet user to communicate, such as e-mail.
2. Those that allow the user to transfer or view information, such as FTP, Gopher or WWW.
3. Those that allow the user to find information, such as Netfind, Veronica, or WebCrawlers.

The most complex tools are the ones associated with the finding of information.

With a working knowledge of this basic set of tools, the average Internet user should be able to find and access a reasonable portion of the available information on a given subject. However, no published articles or studies were found as to what portion of the total available information any one tool was actually able to locate.

II. METHODOLOGY

The methodology of this thesis is an observation of students performing a set of tasks. The organization of this methodology is derived from Emory & Cooper, 1991.

A. DESIGN STRATEGY

This thesis portrays the ability of Information Technology Management (ITM) students to use the Internet effectively. The desired data should provide both a concrete measure of each section's ability and the means for comparison between the sections. A section is an administrative designation used at NPS to denote a group of students curriculum and arrival date. For example, PM33 is the ITM section which arrived in the third(3) quarter of fiscal year 1993. The following set of hypotheses will be used as a basis for the observations conducted:

Hypothesis 1. The ability to perform various tasks using the Internet and student Unix accounts improves with experience, experience being defined as time at the Naval Postgraduate School.

Hypothesis 2. The prime source of the students' ability to use the Internet and their Unix accounts is not through a formal source, such as class assignments, computer center lectures, or computer center personnel, but rather through an informal method of sharing knowledge among themselves.

A set of direct behavioral observations was chosen to test hypothesis 1. Direct observation was chosen in view of the observer's limits in time, money and hardware. An unobtrusive method such as automatic monitoring of activities within a student's Unix account would have provided better data, but this method proved physically unpracticable within the scope of this study.

Three categories of tasks were used as a representative measure of ability as contained in hypothesis 1. These three categories were communications, data transfer and

knowledge acquisition. Time required to perform the task was used as a measure of effectiveness in each case. Although the quickest answer does not necessarily provide the best answer, it was the most suitable measure in this case. This choice of measurement is discussed further below.

a. Communications: Was the subject able to communicate effectively using e-mail, including the acquiring of various unknown e-mail addresses?

b. Data Transfer: Given the location of specific pieces of data, could the subject retrieve them using a variety of tools, such as file transfer protocol (FTP), gopher and the world wide web (WWW)?

c. Knowledge Location: Given a specific topic or site, could the subject locate the requested information?

Hypothesis 2 would be tested in the second portion of the observation, using a short series of demographic questions.

B. MEASUREMENT

Along with discussing the reasons for the various scales used within the observation, this section looks at the validity, reliability, practicality, and error sources associated with the measurements used.

1. Scale

A ratio scale was used for the observation of the tasks associated with hypothesis 1. As discussed in the design strategy, the amount of time required to perform a given task was recorded. Any task requiring more than five minutes was scored as "unable to perform the task." The time taken was recorded by the observer.

An ordinal scale was used for hypothesis 2. Students were asked to rank the top three sources from which they had gained the knowledge they had used in the task-based

portion of the observation. Although this ordinal scale will not allow parametric testing of this data, it is the most appropriate form in which to measure this data. Independent tracking of a source of knowledge was not possible.

2. Validity

Validity is the ability of the observation to measure what it is designed to measure. Content, criterion, and construct validity are the primary concerns.

a. Content validity is the degree to which the observation covers all applicable areas of the material being studied, in this case Internet ability. Based on the literature review and the pilot test, there seems to be good content validity. The three categories chosen to test hypothesis 1, communications, data transfer, and knowledge acquisition, appear to provide adequate coverage of the tasks normally required of a student Internet user. Hypothesis #2 has a very narrow set of possible sources as to where the student acquired his or her skill level. The ordinal questions chosen should provide a complete set of possible answers.

b. Criterion validity is how well the chosen measure, in this case time, represents the actually state of what is being measured. Using time as a measure for hypothesis #1 is not the only possible choice. A measure of the quality of the data delivered per task may have been viable, or an analysis of the technique and thought processes used may also have been of value. However, time is the most useful measure available because it provides the ability to conduct statistical analysis plus it eliminates problems with observer interpretation.

c. Construct validity is the degree to which a measure conforms to other theoretical work. In this case, there were no other studies with which to compare. The tasks the subjects are asked to perform are considered basic and fundamental to using the Internet, therefore, the subjects ability to perform these tasks is a valid measure of actual ability and should have good construct validity.

3. Reliability

Reliability is the degree to which the observation provides consistent results. There are three types of reliability which are of concern: stability, equivalence, and internal consistency.

a. If a subject scores the same on repeated observations then there is stability in the measurement. In this thesis, there were no retests of subjects. Therefore there is no actual means to test the stability of the measured results. However, there appears to be no reason that the measure is not stable. Situational errors may have occurred, as discussed below, but they are a function of observation environment rather than the tool itself.

b. Equivalence considers whether different observers will achieve different results. Again, there is no means to actually confirm equivalence in the observation since there was only one observer. The observer kept interaction with the subjects to a minimum and only recorded objective quantities such as time. A second observer should be able to reproduce similar results.

c. Internal Consistency ensures that similar tasks with one subject will provide similar results. There was no attempt to test internal consistency and there is no way to verify that it exists other than to note whether subjects who performed poorly in certain portions of the observation continued to perform poorly and those who performed well continued to perform well.

4. **Practicality**

Practicality was a major design consideration due to the previously discussed shortcomings in resources, mainly time. The observation was easily carried out by a single observer using a public lab in the course of one work week. All tasks are straight forward with a single possible correct answer, while allowing individual subjects to use

a variety of techniques to reach the answer. The scales used provide a simple, useful data set.

5. Error Sources

There were several opportunities for errors to have been introduced into the measurement process. However, these errors are consistent between sections of the sample, and although they may flaw the empirical data, the relative measures of the data remain valid.

a. Respondent error seems to be minimal. All subjects appeared to the observer to honestly attempt to perform all tasks. All have similar backgrounds with regard to career and social class. There may have been small amounts of error introduced by student anxiety over other classes, et cetera, but this did not appear to be significant.

b. Situational error is the most significant source of error. It was impossible to tailor the lab situation to each subject, therefore there were multiple sources for situational error. Many of the subjects were used to working on home PC-based interface as opposed to a Unix-based workstation. The presence of other students in the lab may have affected the subjects ability to concentrate on the given tasks. The presence of an observer may have also contributed to an uncomfortable atmosphere in which to conduct the experiment. All these factors combined to give an advantage to subjects who were used to working on a Unix workstation in a crowded lab environment.

c. The measurer was a minimal error source. The same observer performed all observations. The personal acquaintance of the observer to any of the subjects did not flaw the observation, since all tasks were of a very objective nature.

d. Instrument was also a minimal source of error. The instrument is simple and has been shown to be valid. Both the pilot test and the actual testing showed the tasks to be clear and complete.

C. SAMPLING DESIGN

Since Hypothesis 1 required various experience levels, a stratified sample of the ITM student population was needed. A sample of five students from each of the four current ITM sections was chosen as the sample that would provide the needed data. This sample size was chosen based on the small total population size. This choice is addressed in detail in the discussion of sample size.

1. Sample Type

The sample was drawn from the ITM student population at large. It was a convenience sample in that the observer had no means of drawing a random sample from the population, mainly because there was no way the observer could compel participation from the randomly selected subjects. Therefore, the observer relied on volunteers to provide the sample set.

2. Sample Size

As previously discussed, five subjects were used from each of the four current ITM sections. This was necessitated by the small size of the total population. The total ITM population by section is as follows:

PM33	27
PM41	53
PM43	28
PM51	57

Table 2. ITM Population by Section

Since there was no basis for an interval estimate, the effects of such a small sample size on the observation could not be determined until the results were examined.

Rather than begin with an interval estimate to determine the desired sample size, the standard deviation of the sample was used to determine the interval estimate with a 0.95 confidence level. Using the standard deviation from each section's sample, the interval estimate was determined as follows:

$$i=(1.96)\frac{s}{\sqrt{n-1}}$$

where

i = Interval estimate in minutes.

s = Standard deviation of the section sample.

n = Sample size, in all sections this number was 5.

1.96 = Standard errors for a 0.95 confidence level.

This equation gives interval estimate (i) by section with 0.95 confidence level as follows:

	s	i
PM33	O.875	51 secs
PM41	0.909	53 secs
PM43	0.852	50 secs
PM51	0.776	46 secs

Table 3. Interval Estimate for Task Observations

Therefore, with a 0.95 confidence level, the results of the observation of the sample set are within 53 seconds of the population as a whole based on the standard deviation of each section's data set and a sample size of five.

By comparison, the population would have been unable to support the observation had interval estimate been used to dictate sample size. An interval estimate of 30 seconds increases the required sample size to 37 subjects per section. Even with a finite population adjustment, the sample size remains over 15 subjects per section. Given the population size this was highly impracticable.

Note: Since the results were in a bipolar distribution, the standard deviation used for each section was taken only from the positive answers and not the "unable to perform task" responses. That is the observations that could be quantified in terms of time. Therefore, the sample mean used to calculate the standard deviation is not representative for use as a comparison between the groups, and was only used as a point around which to measure the deviation of each section.

3. Sample Validity

Validity is also important in the sample process. In this case, validity is how well the sample set represents the entire population. There are two parts to sample validity, accuracy and precision.

a. An accurate sample will have no systemic variances or biases associated with it. The use of a non-random sample could be a source of systematic variance. However, in this case the standard deviations were low enough to make this unlikely.

b. Precision is a reflection of how well the effects of chance have been removed from the sample set. This usually comes into play when all other systemic variances have been accounted for. Again, the low standard deviation of the sample sets shows that there is good precision.

D. THE PILOT TEST

A pilot test of the observation tasks was conducted prior to the actual observation of sample subjects. The pilot test was intended to show errors in both the observation tasks and the observer's technique. The pilot test procedures were identical to the actual observations in controllable respects, such as location, tasks and equipment used. The personal relationship between the subjects and the observer provided the only possible source of error in this procedure.

Three volunteer subjects were chosen from PM33, the senior section. The volunteers were chosen based on the observer's opinion that they provided a valid cross-section of the PM33 population. There was no attempt to maintain randomness in the selection of pilot test subjects.

Although the pilot test subjects showed varied levels of competence on some tasks, their results within each category were very similar. This indicated that the initial group of tasks should be sufficient to provide a representation of each section as a whole.

In post-observation discussion, all three pilot test subjects indicated that the tasks, in their opinions, provided a fair test of their abilities to perform the three categories of tasks. They also anticipated a difference in results between sections due to their own experience in learning to perform the observed tasks.

E. OBSERVATION

The observation was conducted using a Sun Sparc 10 workstation in the public computer lab in Root Hall at the Naval Postgraduate School, Monterey, California. The subjects used their own accounts and were allowed to use any techniques or tools that were available.

III. OBSERVATION RESULTS

This chapter is a summary of the data collected during the task observations. Although, in some cases, this is not the raw data, all cumulative data presented are taken directly from the raw data. In all tables, '-' represents a '0' for ease of visual inspection. The remaining raw data are available in Appendix B. An analysis of these data is provided in Chapter IV.

A. DEMOGRAPHICS

The following data provide the demographic information that was gathered about the subjects during the observation. The demographics concern solely the characteristics of the subjects' Unix account usage. No personal demographics, such as age, sex or military community, were recorded during the observation.

Table 4 is the response to a direct question as to how often a subject logs in to his or her Unix account. The question was posed by the observer to the subjects. It is the subject's own answer, without independent verification. The sample for each section was five subjects.

	PM33	PM41	PM43	PM51
< Once/Week	-	-	-	-
Once/Week	-	-	3	-
2-3/Week	-	-	1	-
4-5/Week	-	-	-	-
6-7/Week	1	-	1	-
> Once/Day	4	5	-	5

Table 4. Login Frequency

The data for Table 4 were not independently gathered or confirmed. There is no confidence factor or interval estimate computed for this data. The data, however, still provide insights into the usage patterns of ITM students. The interpretation of these data will be discussed in more detail in Chapter IV.

Table 5 shows the extent to which a subject customized his or her computer center account workspace. This was recorded by the observer without input from a subject. In this case, customization is defined as any modification to the standard Unix X-windows workspace that allows a subject to function more effectively. In Table 5 "yes" means the account was customized, and "no" means the account was not.

A hotlist, as used in Table 5, is a personalized list of Uniform Resource Locators (URLs) maintained within a World Wide Web (WWW) browser, such as Netscape or Mosaic. A hotlist allows a subject to mark locations that he or she feels will be useful for future reference. A URL in a hotlist defines both the Internet address and the type of server for a given WWW page. An example of a URL maintained in a hotlist would be "ftp://www.nps.navy.mil/". This is the File Transfer Protocol (FTP) server residing on "www.nps,navy.mil," the Internet Protocol(IP) address of the machine. In Table 5, the observer noted the total number of entries in each subject's hotlist and used this to provide the average given for each ITM section.

Table 5 also provides some statistical information, namely standard deviation and interval estimate, for this data. This information was calculated using the same method discussed in detail in Chapter II, under "Sample Size."

	Yes	No	Average Hotlist	sd	i
PM33	5	-	26.0	8.0	7.84
PM41	4	1	8.4	13.1	12.84
PM43	4	1	2.8	2.4	2.35
PM51	1	4	0.0	0.0	0.0

Table 5. Customized Environment
sd=standard deviation
i=interval estimate

Subjects were also asked if they had access to a Unix based computer account at their home or previous command prior to arrival at the Naval Postgraduate School. All subjects stated that they did not have previous access. Again, these were the subject's responses and were not independently verified by the observer.

B. OBSERVATIONS

The following data were gathered during the task observations conducted on ITM students at the Naval Postgraduate School. These groups of observations were designed to test the hypotheses discussed in the Methodology:

Hypothesis 1. The ability to perform various tasks using the Internet and student Unix accounts improves with experience, experience being defined as time at the Naval Postgraduate School.

Hypothesis 2. The prime source of the students' ability to use the Internet and their Unix accounts is not through a formal source, such as class assignments, computer center lectures, or computer center personnel, but rather through an informal method of sharing knowledge among themselves.

The first four of the following tables (Tables 6 through 9); communications, data transfer, data location and cumulative results; are associated with hypothesis 1. These tables are based on direct behavioral observation by the observer, without input from the subject. The interval estimate for this group of observations was determined in Chapter II, under "Sample Size." As discussed there, the sample data provided were within 53 seconds of the actual ITM population with a confidence of 0.95. One column on Tables 6 through 9 equals 60 seconds. Each ITM section's results for each specific task are contained in Appendix B. Individual subject's results are not provided. For each of the areas, the actual tasks used in the observation are contained in Appendix A.

1. Communications

Table 6 represents the cumulative totals for the four observed tasks associated with communication. All sections seemed to perform equally well on these tasks. As shown in the Literature review, these were the easiest tasks in the observation. Specifically, these communications tasks were:

A1. Send an E-mail message.

A2. Find a local (NPS) E-mail address.

A3. Find an E-mail address within the same domain (.mil).

A4. Find an E-mail address in an outside domain.

A domain in this case is the top-level of an e-mail IP address, such as .edu or .mil.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	13	-	-	-	-	7
PM41	9	-	1	-	-	10
PM43	7	1	-	-	-	12
PM51	11	-	-	-	-	9

Table 6. Communication Tasks Performance

2. Data Transfer

Table 7 represents the cumulative totals for the four observed tasks associated with data transfer. Performance stayed consistent at this point, except for an improvement in PM33 and a decrease in PM43. These tasks could also be considered less difficult than the data location tasks. Specifically, these data transfer tasks were:

B1. Perform basic file management (create, modify and delete files) within subject's own account.

B2. Download a file from a given FTP site.

B3. Access a given Gopher site.

B4. Access a given WWW site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	11	5	1	-	-	3
PM41	6	5	3	-	-	6
PM43	4	4	1	1	-	10
PM51	5	5	-	-	-	10

Table 7. Data Transfer Tasks Performance

3. Data Location

Table 8 represents the cumulative totals for the four observed tasks associated with data location. These were the most difficult of the observed tasks. PM33 continued to show strong performance, while the other sections showed a decrease in performance. This was the task set that gave PM33 its overall edge, as shown in Table 9. Specifically, these data location tasks were:

C1. Find general information on a given topic.

C2. Find a specific piece of information.

C3. Find a specific Gopher site.

C4. Find a specific WWW site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	8	4	5	-	1	2
PM41	3	1	2	-	2	12
PM43	2	3	2	-	-	13
PM51	2	4	2	1	-	11

Table 8. Data Location Tasks Performance

4. Cumulative Results for Hypothesis 1

Hypothesis 1. The ability to perform various tasks using the Internet and student Unix accounts improves with experience, experience being defined as time at the Naval Postgraduate School.

Table 9 shows the cumulative results of Tables 6 through 8. Two things appear significant with this table. First, PM43 performed poorer than all the other sections, including PM51. Second, PM33 out performed the other sections. These assumptions will be examined in detail in Chapter IV.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	32	9	6	-	1	12
PM41	18	6	6	-	2	28
PM43	13	8	3	1	-	35
PM51	18	9	2	1	-	30
Total	81	32	17	2	3	105

Table 9. Cumulative Task Performance

5. Knowledge Source

Table 10, knowledge source, is associated with the second hypothesis:

Hypothesis 2. The prime source of the students' ability to use the Internet and their Unix accounts is not through a formal source, such as class assignments, computer center lectures, or computer center personnel, but rather through an informal method of sharing knowledge among themselves.

Table 10 represents the responses given by the subjects when asked to rate the top three sources for the knowledge they displayed in performing the previous sets of tasks. The responses were recorded as supplied by the subjects. They were not independently verified by the observer.

The weighted total in Table 10 is given to provide a more intuitive means of comparison between the different sources of knowledge. The responses were weighted as follows: Responses rated 1st were given a weight of 3; responses rated 2nd were given a weight of 2; and responses rated 3rd were given a weight of 1.

The 2nd and 3rd response rating columns do not equal the possible total of twenty because several subjects responded with null answers.

Source	1st	2nd	3rd	Total	Weighted Total
CC Personnel	-	-	3	3	3
CC Class	1	-	-	2	4
CC Handout	-	1	3	4	5
On Own	10	3	3	16	39
Classmates	7	7	1	15	36
Assignment	2	6	3	11	21
Other	-	-	-	-	-

Table 10. Student's Source of Knowledge
(CC = Computer Center)

Statistical analysis and interpretation of all observation data are provided in Chapter IV. Any raw data not presented here are given in Appendix B.

IV. ANALYSIS OF RESULTS

This chapter will analyze the raw data reported in Chapter III, and determine if it supports the thesis hypotheses. It will also look at possible causes of any anomalies in the data.

A. DEMOGRAPHICS

The demographics alone do not provide support for any of the research questions of this thesis. They do, however, draw attention to some questions that arose during the examination of the data.

The most puzzling question that arose concerns the performance and demographics of PM43. There seems to be a correlation between Table 4 and Table 11. Table 11 shows PM43 performing worse than PM51 on the cumulative task results, which seems illogical due to PM43's supposedly greater experience. Table 4 shows PM43 with much less account usage than all the sections, including PM51. There appeared to be some systematic variance in the data.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	32	9	6	-	1	12
PM41	18	6	6	-	2	28
PM43	13	8	3	1	-	35
PM51	18	9	2	1	-	30
Total	81	32	17	2	3	105

Table 11. Cumulative Task Performance
ITM Section versus Time
(N/A = Not Able to Perform Task)

There were two possible causes discovered for this problem with PM43. One is a sampling error on the part of the observer and the other is an uncontrolled outside influence upon PM51, which gives the mistaken impression of a problem in PM43's performance. The sample taken was not random. Instead it relied on volunteers. In the case of PM43, one person facilitated the recruitment of volunteers for the observations. If this person used acquaintances with the same social and educational backgrounds, and if this background was conducive to poor performance on the task observations, then this sample bias may be the source of the problem.

The other possible source of the inconsistency is a systematic variance in PM51's data. In other words, PM43's performance was not sub-par, but instead PM51's performance was superior. Upon investigation, it became known that PM51 did receive outside assistance in learning about the Internet. Several students from PM31, a previous graduated ITM section, remained on campus while awaiting orders. One of these students, through personal connections, assisted PM51 in getting started with their Unix accounts. PM51 also showed an increased response towards formal methods, as shown in Appendix B. These factors combined may have caused PM51's ability to increase. The problem, therefore, was not a problem with PM43, but rather an over achievement by PM51. This is believed to be the actual cause of the observed variance in the data.

The demographics showed no other problems in the data. Account customization was consistent with the hypothesis that the more experienced sections were more sophisticated in there Internet usage.

B. HYPOTHESIS 1

Hypothesis 1. The ability to perform various tasks using the Internet and student Unix accounts improves with experience, experience being defined as time at the Naval Postgraduate School.

An Analysis of Variance (ANOVA) was used to test hypothesis 1. An ANOVA is used to test if the means of several sample sets are statistically equal. It compares the effect of different independent variables on the dependent variable.(Emory & Cooper, 1991) In this case, the time taken by a task was used as the dependent variable, while ITM section was the independent variable.

One problem involved with using the ANOVA was how to represent the "Not Able" or "N/A" responses for the subjects who took longer than five minutes. "N/A" must somehow be presented as interval data. There seemed to be two possible ways to do this.

One option would be to give "N/A" an arbitrary numerical value based on some quantity such as mean time for receiving help from a computer center consultant. The problem with this method was determining an equitable numerical value to assign to "N/A." It was felt that the "N/A" response could be any length of time from slightly more than five minutes to possibly indefinite. This option was deemed unreliable and unscientific.

The second option was based on the bipolar distribution of the data. As shown in Table 12, most measurable responses occurred early in the task observation. This shows that for most subjects, they either could perform the task or they could not. In other words, they were not able to work through the task if they did not immediately know the procedure. This dichotomy presented the opportunity to assign integer values to whether the subject was able to perform the task or not.

	<1	1-2	2-3	3-4	4-5	N/A
Total	81	32	17	2	3	105

Table 12. Cumulative Response Time

Therefore, for the ANOVA test of hypothesis 1 presented in Table 13, subjects who were able to perform the tasks were assigned a value of one. Subjects who were unable to perform the task were assigned a value of zero.

The null hypothesis(H_0) used to check hypothesis 1 is that the task performance of each section is statistically equal to the task performance of the other sections. Table 13 shows the results of the ANOVA for each task category plus for the cumulative.

Null Hypothesis:

$$H_0: P_{33}=P_{41}=P_{43}=P_{51}$$

where: P = performance on given task set

subscript = ITM section

Tasks	Sum of Squares	DF	Mean Squares	F	Sig of F
Communications	.650	3	.217	.853	.469
Data Transfer	1.737	3	.579	2.628	.056
Data Location	3.850	3	1.283	6.058	.001
Cumulative	4.946	3	1.649	7.190	.000

Table 13. ANOVA of Task Results

Using $p<.05$ as the cutoff point, we failed to reject the null hypothesis in the case of communications and data transfer. This means that all four ITM sections performed statistically equal on these tasks. In the case of data location, however, we did reject the null hypothesis, showing that the different ITM sections were not equal.

The tools used with information location are more complex than those used for communications and data transfer. This is consistent with failing to reject the null hypothesis for communications and data transfer, but rejecting it for data location.

We also rejected the null hypothesis for the cumulative data. While this supports our hypothesis, the cumulative calculations also had the advantage of a data set three times as large as the non-cumulative tasks. The increased size of the data set made even minor variations statistically significant.

C. HYPOTHESIS 2

Hypothesis 2. The prime source of the students' ability to use the Internet and their Unix accounts is not through a formal source, such as class assignments, computer center lectures, or computer center personnel, but rather through an informal method of sharing knowledge among themselves.

Statistical analysis was performed on the data using a Friedman Two-Way ANOVA. A Friedman Two-Way ANOVA examines the variance of ranked data within each block. A block in this case was one subject. It is based on two assumptions. One, that the results of one subject do not influence any other subject. Two, that each subject's data is arranged in a rank order. Both of these criteria were met by the observation data for hypothesis 2. (Conover, 1971)

Again, there was a problem with null data. The subjects were asked to rank only their top three choices out of a possible six choices. It was decided to give all null data the rank of four. Therefore, each block of data would have the top three sources, as ranked by the subjects, and all remaining options would be given the rank of four. The Friedman Two-Way ANOVA is tolerant of ties in the ranked data. (Conover, 1971)

The Friedman Two-Way ANOVA provides two pieces of information. One, a mean rank for each variable, and two, a significance factor for testing a null hypothesis of equality.

The null hypothesis used for hypothesis 2 was that all sources of ability were ranked equal. Table 14 shows the results of the Friedman Two-Way ANOVA testing the following null hypothesis.

Null Hypothesis(H_0):

$$H_0: S_1=S_2=S_3=S_4=S_5=S_6$$

where: subscript = specific source as shown in Table 15.

χ^2	DF	Sig
32.6857	5	.000

Table 14. Friedman Two-Way ANOVA Results

Using a $p<.05$ cutoff, we were able to reject the null hypothesis. Therefore, the sources that subjects reported for where they learned the Internet were not statistically equal.

The rest of the information provided by the Friedman Two-Way ANOVA is given in Table 15. This gives us the mean rank of the data over all subjects.

S_n	Source	Mean Rank
1	CC Personnel	4.47
2	CC Class	4.47
3	CC Handout	4.32
4	On Own	2.15
5	Classmates	2.40
6	Assignment	3.17
-	Other	-

Table 15. Mean Rank of Knowledge Sources

Overall, this shows that "On Own" and "Shown by Classmates" are the common source of learning Internet techniques. These can be considered the informal techniques, thus supporting the hypothesis that students are learning in informal ways. The only formal method worth mentioning is "class assignments" which performed far better than the Computer Center related sources. The results of each individual section are shown in Appendix C.

The one exception is PM51's individual results, as shown in Appendix C, which show a stronger use of formal methods. This is the only section which did not rank "on own" and "shown by classmates" as the top two sources. PM51, instead, ranked "class assignments" as their top choice. This is assumed to be the result of more classroom instructors beginning to including the Internet in their class materials.

The consequences of these observations will be discussed in Chapter V , "Conclusions and Recommendations."

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. Study Benefits

This thesis has portrayed the current state of Internet usage by ITM students at the Naval Postgraduate School. ITM students are expected to function as the future DoD IT managers. In this role they will need to be literate in the use of the Internet. It has shown the need for earlier direction in teaching the Internet to ITM students.

As a secondary benefit, the data recorded in this thesis may also be useful in future research as both a starting point and a baseline for comparison against new data.

2. Research Questions

Is there a relationship between experience and the ability to use the Internet effectively? The answer is a definite yes. This in itself is not remarkable, and in fact seems quite obvious. The interesting revelation is the characteristics of the relationship.

Only PM33's performance could be considered remotely adequate, and even PM33 was only able to perform 48 out 60 tasks, or 80%. The other sections performance should be considered substandard. This is not necessarily a major problem. Students, as shown by PM33, are becoming Internet literate before they leave NPS. They are not, however, receiving the full benefit of Internet usage during their entire course of study at NPS.

What instructional source has taught ITM students to use the Internet? The overall source of instruction is very informal. There is certainly a correlation between this fact

and the low scores show by all sections except PM33. Informal learning methods are likely to be more inefficient than formal ones.

There is however, as shown in Table 16, a migration towards more formal methods taking place. This should be considered a positive sign as shown by PM51's advanced performance.

S_n	Source	PM33	PM41	PM43	PM51
1	CC Personnel	4.60	4.00	4.70	4.60
2	CC Class	4.60	4.80	3.90	4.60
3	CC Handout	4.20	4.20	4.70	4.20
4	On Own	1.20	2.00	2.50	3.20
5	Classmates	2.20	2.40	2.00	2.60
6	Assignment	4.20	3.60	3.20	1.80

Table 16. Source Rank by Section

B. RECOMMENDATIONS

The following recommendations are designed to improve the ability of ITM students to use the Internet, based on the results of the research questions.

Based on the research conducted in this thesis, formal classroom instruction is needed to teach ITM students the Internet. This conclusion is based on the current informal methods used and the low observation performance they produced. If a formal class is impracticable, then an online tutorial may be appropriate. The advantages and disadvantages of both options should be examined in detail as possible future research.

Currently, the majority of the students learn through informal methods. Non-mandatory computer center classes are available to all these students. They are not being

used. If this status quo continues, without the adoption of a formal Internet class, then an online tutorial would be the appropriate instructional tool. Stimulating usage will most likely continue to be a drawback with any non-mandatory method.

However, it has also been shown that there is a gradual shift taking place towards formal instruction as shown by PM51's results. If it is desired for this trend to continue, then a formal Internet class would be the appropriate solution. A formal class would follow a standard teaching methodology, which would provide a much greater chance of long term comprehension than informal methods.

1. Online Tutorial

Constructing an online tutorial should almost certainly be considered. Even if a formal class structure is adopted, a ready reference source would be invaluable until the students became more sophisticated in customizing there own environment and tools.

The most useful form for a tutorial would be a WWW based page on a server controlled by the ITM curriculum, or at least by the Systems Management curriculum.

An online tutorial also has the benefit of portability. With the increased use of the Internet within DoD, this could have several advantages. A well designed tutorial could be exported to other curriculums and DoD activities with WWW capabilities. Also, if there were any interest in standardizing what resource discovery tools and services were used within DoD, a canned tutorial could be a way to publicize them.

2. Class Instruction

The preferred means of teaching the Internet, however, would be the formal classroom instruction. A basic Internet skills curriculum would not occupy enough material to fill an entire quarter course. It would be better taught as a portion of an

introductory course such as IS2000 or as an independent half quarter course during the refresher quarter.

Formal classroom instruction also has the advantage of being mandatory. Hopefully, mandatory instruction will not be necessary once the student sees the advantages of using the Internet, but until that time, class assignments would point the student in the right direction.

C. FURTHER RESEARCH

Based on the above recommendations, follow-on research into designing a tutorial or class may be useful. Further testing to verify the results of these implementations would then also be useful.

1. Design the online tutorial to be used. This would require a strong familiarization with hypertext mark-up language (html) and its associated use on WWW servers. It would also require research in tutorial design methods. Finally, the material for constructing the tutorial would have to be gathered and verified.

2. Design the class syllabus for an Internet course. Again, this would require the gathering and verification of the class material. This material would then have to be placed into a logical sequence, and the associated teaching media developed.

3. Test the effectiveness of whatever new techniques are implemented. This would consist of reconducting the observations of this thesis. These new results would be compared to this thesis's baseline results. This would confirm the effectiveness of whatever new instruction methods were chosen. Even if no new methods were implemented, tracking the growing use of the Internet in other ITM classes would at least confirm the results shown by PM51.

APPENDIX A. OBSERVATION TASKS

A1. Send E-mail to the following address: afmusgro@nps.navy.mil
Subject: Test Body: This is a test.

A2. William J. Haga is a faculty member at NPS, find his e-mail address.

A3. Bill Doe is in the Army, location unknown, find his e-mail address.

A4. Karen Jones works at the University of Alaska at Fairbanks, find her e-mail address.

B1. Create a file "test", move it to any other directory, then delete it.

B2. Download the file "newnames.txt: from the following FTP site:
site: byrd.mu.wvnet.edu login: anonymous
directory: pub/history/military/USN

B3. Access the following gopher site:
gopher.ucr.ac.cr

B4. Access the following WWW page:
http://wsk.eit.com/

C1. Find information on the subject "alienation".

C2. Find a copy of Sir Walter Scott's book <u>Ivanhoe</u>.

C3. Find the following gopher site:
PATHY Gopher for Medical Information

C4. Find the following WWW page:
EUNet Norway Information Services

For the above tasks, where did you gain your knowledge (rank the top three):
a. Shown by Computer Center Personnel
b. Attended Computer Center Class
c. Read Computer Center Handout/Bulletin
d. On your own/exploring
e. Shown by classmates
f. From class assignments in a required course
g. Other (please specify)

APPENDIX B. OBSERVATION RAW DATA

Demographics

Hotlist Size by Subject and Section

						AVG
PM33	39	20	27	19	25	26.0
PM41	0	12	0	0	30	8.4
PM43	9	2	0	0	3	2.8
PM51	0	0	0	0	0	0.0

Task Observations

For ease of visual examination all "0" responses have been replaced with a "-."

Communications

A1. Send an E-mail message.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	5	-	-	-	-	-
PM41	5	-	-	-	-	-
PM43	3	1	-	-	-	-
PM51	5	-	-	-	-	-

Communications (continued)

A2. Find a local E-mail (NPS) address.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	5	-	-	-	-	-
PM41	2	-	-	-	-	3
PM43	3	-	-	-	-	2
PM51	5	-	-	-	-	-

A3. Find an E-mail address within the same domain (.mil).

	<1	1-2	2-3	3-4	4-5	N/A
PM33	3	-	-	-	-	2
PM41	2	-	-	-	-	3
PM43	1	-	-	-	-	4
PM51	1	-	-	-	-	4

A4. Find an E-mail address in an outside domain.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	-	-	-	-	-	5
PM41	-	-	1	-	-	4
PM43	-	-	-	-	-	5
PM51	-	-	-	-	-	5

Data Retrieval

B1. Perform basic file management.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	4	1	-	-	-	-
PM41	2	1	2	-	-	-
PM43	-	3	-	-	-	2
PM51	2	-	-	-	-	3

B2. Download a file from a given FTP site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	-	4	1	-	-	-
PM41	-	2	-	-	-	3
PM43	1	1	1	-	-	2
PM51	-	4	-	-	-	1

B3. Access a given Gopher site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	2	-	-	-	-	3
PM41	1	1	-	-	-	3
PM43	-	-	-	1	-	4
PM51	1	1	-	-	-	3

Data Retrieval (continued)

B4. Access a given WWW site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	5	-	-	-	-	-
PM41	3	1	1	-	-	-
PM43	3	-	-	-	-	2
PM51	2	-	-	-	-	3

Data Location

C1. Find general information on a given topic.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	3	-	2	-	-	-
PM41	1	-	1	-	-	3
PM43	1	-	2	-	-	2
PM51	1	2	1	-	-	1

C2. Find a specific piece of information.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	3	-	1	-	-	1
PM41	1	-	-	-	-	4
PM43	1	1	-	-	-	3
PM51	1	2	-	1	-	1

C3. Find a specific Gopher site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	-	2	1	-	1	1
PM41	-	-	-	-	2	3
PM43	-	1	-	-	-	4
PM51	-	-	-	-	-	5

C4. Find a specific WWW site.

	<1	1-2	2-3	3-4	4-5	N/A
PM33	2	2	1	-	-	-
PM41	1	2	1	-	-	2
PM43	-	1	-	-	-	4
PM51	-	1	1	-	-	4

Source of Knowledge by Section

CC = Computer Center
Weighted Total: 1st = 3
2nd = 2
3rd = 1

PM33

Source	1st	2nd	3rd	Total	Weighted Total
CC Personnel	-	-	-	0	0
CC Class	-	-	-	0	0
CC Handout	-	-	1	1	1
On Own	4	1	-	5	14
Classmates	1	3	-	4	9
Assignment	-	-	1	1	1
Other	-	-	-	0	0

Source of Knowledge by Section (continued)

PM41

Source	1st	2nd	3rd	Total	Weighted Total
CC Personnel	-	-	2	2	2
CC Class	-	-	-	0	0
CC Handout	-	1	-	1	2
On Own	3	1	-	4	11
Classmates	1	2	1	4	8
Assignment	1	-	1	2	4
Other	-	-	-	0	0

PM43

Source	1st	2nd	3rd	Total	Weighted Total
CC Personnel	-	-	-	0	0
CC Class	1	-	-	1	3
CC Handout	-	-	-	0	0
On Own	2	-	2	4	8
Classmates	2	2	-	2	10
Assignment	-	2	1	3	5
Other	-	-	-	0	0

PM51

Source	1st	2nd	3rd	Total	Weighted Total
CC Personnel	-	-	1	1	1
CC Class	-	-	1	1	1
CC Handout	-	-	2	2	2
On Own	1	1	1	3	6
Classmates	3	-	-	3	9
Assignment	1	4	-	5	11
Other	-	-	-	0	0

APPENDIX C. FRIEDMAN TWO-WAY ANOVA RESULTS

Mean Ranks by Section

S_n	Source	PM33	PM41	PM43	PM51
1	CC Personnel	4.60	4.00	4.70	4.60
2	CC Class	4.60	4.80	3.90	4.60
3	CC Handout	4.20	4.20	4.70	4.20
4	On Own	1.20	2.00	2.50	3.20
5	Classmates	2.20	2.40	2.00	2.60
6	Assignment	4.20	3.60	3.20	1.80

PM33

χ^2	DF	Sig
14.8286	5	.0111

S_n	Source	Mean Rank
1	CC Personnel	4.60
2	CC Class	4.60
3	CC Handout	4.20
4	On Own	1.20
5	Classmates	2.20
6	Assignment	4.20
-	Other	-

PM41

χ^2	DF	Sig
8.4286	5	.134

S_n	Source	Mean Rank
1	CC Personnel	4.00
2	CC Class	4.80
3	CC Handout	4.20
4	On Own	2.00
5	Classmates	2.40
6	Assignment	3.60
-	Other	-

PM43

χ^2	DF	Sig
9.1143	5	.1046

PM43 (Continued)

S_n	Source	Mean Rank
1	CC Personnel	4.70
2	CC Class	3.90
3	CC Handout	4.70
4	On Own	2.50
5	Classmates	2.00
6	Assignment	3.20
-	Other	-

PM51

χ^2	DF	Sig
9.5714	5	.0883

S_n	Source	Mean Rank
1	CC Personnel	4.60
2	CC Class	4.60
3	CC Handout	4.20
4	On Own	3.20
5	Classmates	2.60
6	Assignment	1.80
-	Other	-

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